City of Memphis
Maynard C. Stiles Wastewater Treatment Plant
Disinfection Improvements

Pilot Study Phase 2 Summary
January 30, 2015

Background

The objective of the full-scale peracetic acid (PAA) pilot study is to identify the best disinfection control strategy to achieve compliance with the future NPDES permit disinfection limits under varying flows and influent quality conditions. The Pilot Study Work Plan, previously developed and approved in 2014, includes a description of Dose Control Strategy, Phases of Testing, Data Analysis, Pilot Study Management, and Additional Industrial User Testing to be conducted.

The pilot is being conducted in phases; the first four include development of information on the best means of providing dose control. A fifth phase will be used to demonstrate efficacy of the final process control algorithm. Data collected during the pilot will be used to inform the final design of the dose control for the full-scale system design. This document provides a summary of the results of Phase 2.

Phase 2: Implementation

The wastewater from the north and south sides of the plant meet and discharge into the mixing compartment at the head of the contact tank. The combined flow is split into two parallel, serpentine contact channels. Pre-disinfection water quality, including color, chemical oxygen demand (COD), and undisinfected *E. coli*, is assessed at the head of the disinfection channel that is not receiving PAA. The water quality parameters are being measured continuously on-line, during this phase are as follows:

- Color - ChemScan UV-3151 series flow-thru sensor
- COD - YSI CarboVis 701 submersible probe

PAA residuals were measured throughout the disinfection channel by three separate, Ducotest Amperometric PAA sensors, P1, P2 and P3, as shown in Figure 1. Bacterial samples were also collected at several locations throughout the basin during testing, with locations also shown in Figure 1.

Using data from Phase 1, color was selected as the water quality parameter for the feed forward control strategy based on the quality of fit between PAA demand and wastewater color. The PAA dose during Phase 2 was determined by selecting a base PAA setpoint dose and adding additional PAA that is equivalent to the calculated demand from the wastewater characteristics, as shown in Equation 1. Here, the PAA demand is calculated as a function of color, as determined during Phase 1.

$$PAA_{dose} = PAA_{setpoint} + PAA_{demand} \qquad \textbf{Equation 1}$$

During Phase 2, color was continuously monitored as described above, and the chemical feed pump PLC calculates PAA demand from the measured color; this value is added to the initial setpoint to pace chemical feed. During the ten days of Phase 2, two different $PAA_{setpoint}$ values were tested; the initial $PAA_{setpoint}$ value was increased by 50% of the initial dose setpoint halfway through Phase 2.

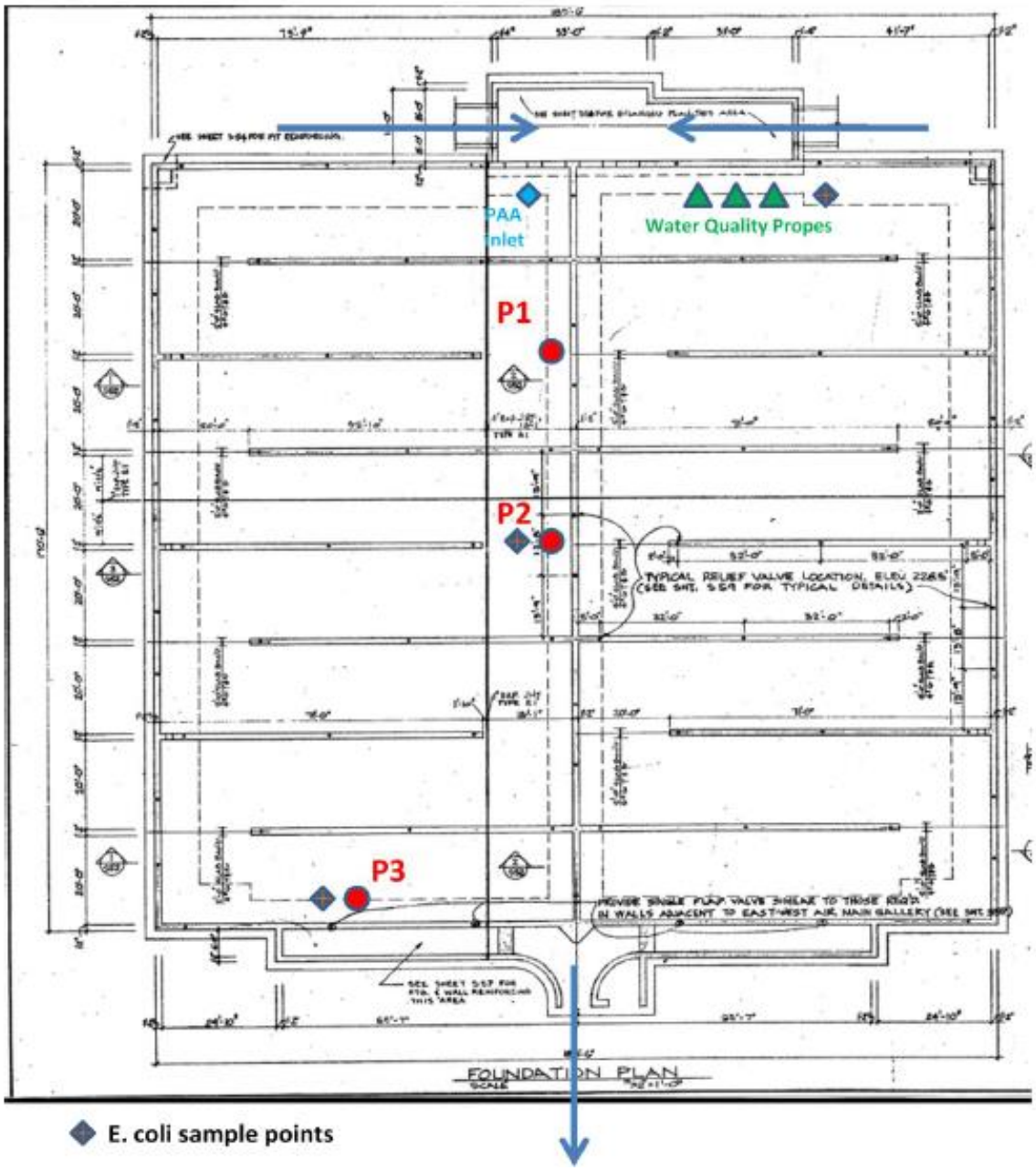

Figure 1. Water quality monitoring and sampling locations in disinfection contact tank.

Phase 2: Results

Phase 2 was initiated on January 7, 2015 and concluded on January 17, 2015. Data for PAA dose was plotted along with effluent color, and PAA residual measured at Probe 1, and is provided in Figure 2. The PAA residuals at P2 and P3 were near the detection limit of the analyzer throughout the phase and are not shown; as a result, the analysis of Phase 2 data is based on the residuals reported at P1, which are shown in Figure 3 along with *E. coli* results.

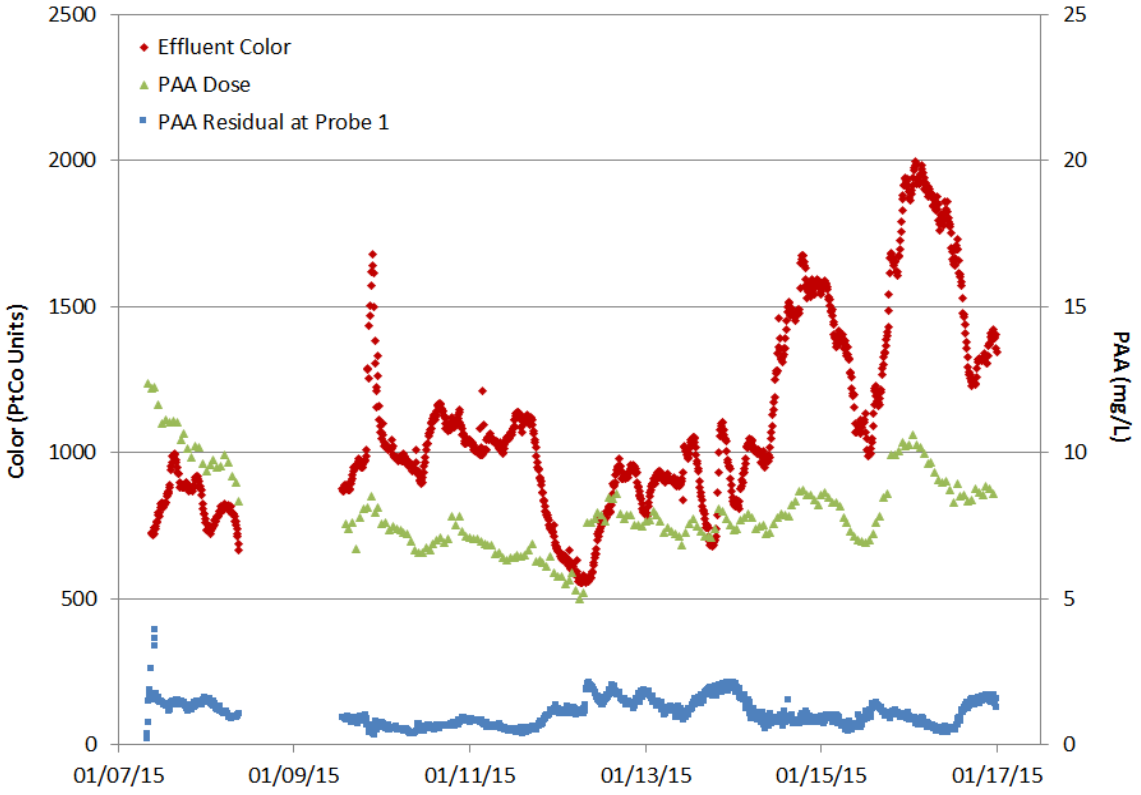

Figure 2. Color and PAA residual measurements during Phase 2.

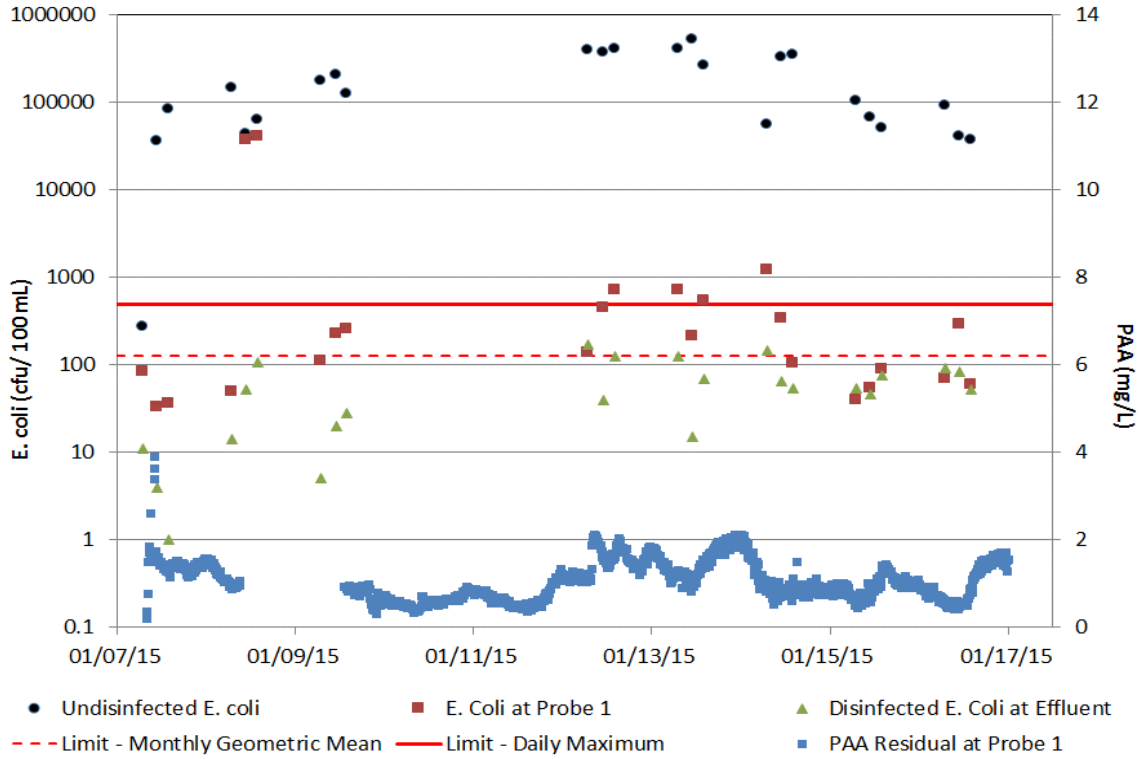

Figure 3. *E. coli* results and PAA residual measurements at Probe 1 during Phase 2.

It is of note that during Phase 2, the data logger stopped recording from January 8, 2015, 9:10 am to January 9, 2015, 1:00 pm; the cause is not known, however, it is not anticipated that this gap in the data set will alter the conclusions drawn from Phase 2. Additionally, in Figure 2, a jump in the PAA dose may be noted on January 12, 2015; this was the planned increase in PAA dose halfway through the study.

Results of the bacteria tested showed that color was a good feed forward parameter for managing disinfection process control. All but two samples were below the monthly geometric mean limit for *E. coli*; additionally, all samples were below the maximum daily limit, thus test data would meet compliance requirements. The *E. coli* data at Probe 1 shows that in most cases, the majority of the disinfection is accomplished in the first few minutes of contact; however, it is necessary to provide additional contact time to achieve disinfection to meet permit requirements.

In addition to the online color data collected on the undisinfected effluent, grab samples were also collected at the influent (at the location of the water quality probes) and at the effluent of the contact basin (near Probe 3) for laboratory measurements of apparent and true color. Apparent color is the direct color reading of the sample, while true color represents the results of the filtered sample. Data for these daily grab samples is summarized in Table 1. It is of note that on average, throughout the treatment in Phase 2 of testing, that the PAA reduced the color of the effluent by approximately 100 Platinum-Cobalt (PtCo) units. It was not anticipated that PAA would have a significant impact on effluent color; this is a secondary benefit of PAA for disinfection at the Stiles WWTP.

Table 1. Summary of daily apparent and true color data collected from grab samples

Date	Apparent Color (PtCo units)			True (filtered) Color (PtCo units)		
	Untreated flow	PAA treated flow	Difference	Untreated flow	PAA treated flow	Difference
01/08/15	467	394	-73	336	269	-67
01/09/15	908	844	-64	802	624	-178
01/10/15	1264	1124	-140	870	696	-174
01/11/15	1208	1148	-60	824	696	-128
01/12/15	960	760	-200	508	396	-112
01/13/15	1000	872	-128	520	460	-60
01/14/15	1252	1056	-196	770	624	-146
01/15/15	850	626	-224	354	255	-99
01/16/15	572	550	-22	1392	1220	-172
01/17/15	686	646	-40	151	133	-18
01/18/15	500	498	-2	149	112	-37
Average Color Reduction			-104			-108

Summary and Future Testing

Based on the results of this Phase of testing, as anticipated from data collected during Phase 1, color was readily correlated to disinfection performance. Additionally, this parameter which was used as the feed forward parameter for Phase 2 of testing provided to be an excellent process control parameter for managing the disinfection process. Additionally, results from daily grab samples for color at the influent and effluent of the contact basin showed that PAA notably reduced the color of the effluent which is an unanticipated secondary benefit of PAA for disinfection at the Stiles WWTP. The next phase of testing (Phase 3) will be conducted similar to Phase 2, however, COD will be used as the feed forward parameter. Phase 3 is scheduled to start on January 19, 2015.